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Trends in Activities of Daily Living among Stroke Survivors: Analysis from the South London Stroke Register

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ABSTRACT

Background National and international acute stroke care guidelines came into effect during the last decade to improve outcomes after stroke but their impact on activities of daily living (ADL) improvement over time is not known. The aim of the study was to examine post-stroke ADL trends over time in a multiethnic population in England, and to examine these trends in different socio-economic groups.

Methods Data from the South London Stroke Register were analysed from 1995 to 2011. At 3 months and 1 year post-stroke, basic and instrumental ADL were measured using Barthel Index (poor outcome- BI score<15) and Frenchay Activities Index (poor outcome- FAI score<=15), respectively. Simple and multiple logistic regression analyses were performed.

Results At 3 months post-stroke, the prevalence of poor basic ADL reduced significantly from 33.4% in 1995-1998 to 25.1% in 2008-2011 (trend p<0.001) and poor instrumental ADL declined significantly from 59.8% to 53.1% (trend p=0.005). The corresponding figures at 1 year were: from 27.8% to 24.3% (trend p=0.001) and from 51.6% to 42.8% (trend p=0.004). At 3 months, significant reduction in poor ADL was observed over time in the first (least deprived) and second Index of Multiple Deprivation (IMD) tertiles (trend p=0.006 and 0.001, respectively in poor basic ADL; 0.019 and 0.047, respectively in poor instrumental ADL). At 1 year, poor basic ADL declined significantly in the first and third IMD tertiles (trend p=0.002 and 0.043, respectively), whereas poor instrumental ADL reduced significantly only in the first IMD tertile (trend p=0.05).

Conclusion ADL has improved over time among stroke survivors. This may reflect the effectiveness of acute stroke care. Disparities in ADL improvement still exist in different socio-economic groups, and health inequality needs to be tackled.

Key words Activities of daily living (ADL), Stroke, Time trends

INTRODUCTION

Stroke is a major chronic illness with high morbidity rates. During the last decade, improved survival after stroke has lead to an increase in its prevalence in the United Kingdom (UK)[1]. In England, stroke is the largest cause of major adult disability, leading to severe and moderate disabilities in around 300,000 people[2]. Activities of daily living (ADL) can be classified into two: basic [primary level of activities which are necessary for daily living (self-care tasks)][3] and instrumental (not necessary for basic functioning, but allow a person to live independently within a community)[4]. Stroke can have a major negative impact on a patient's performance of ADL. The issue of poor ADL after stroke is of major importance, as this places a burden on the individual, family, community and health services[5].

Stroke survivors have been reported as showing improvements in basic and instrumental ADL from stroke onset to 3 months and 1 year post-stroke[6-10]. A number of studies have reported predictors of poor ADL at 3 months and 1 year post-stroke such as gender, age of stroke onset, marital status, living conditions, pre-stroke basic ADL, hemiparesis, motor impairment, urinary incontinence, visuoperceptual deficit, communication problem, intelligence/memory impairment and total anterior circulation infarction[8,10-13]. In general, socio-economic status is found to be associated with ADL[14], and further research on ADL trends over time in different socio-economic groups has been recommended[6,15].

During the last decade, a number of national guidelines especially on acute stroke care (National Service Framework for Older People-2001, National Audit Office Report-2005 and 2010, National Stroke Strategy-2007, and National Clinical Guidelines for Stroke-2008) came into effect to improve outcomes after stroke[2,16-19]. Other international guidelines also addressed this issue of improvement of outcomes after stroke[20-21]. However, their impact on ADL improvement over time is not known. Evidence suggests that no study has examined post-stroke ADL trends over time. The aim of the study was to examine post-stroke ADL trends over time in a multiethnic population in England, and to examine these trends in different socio-economic groups.

MATERIAL AND METHODS

Study population, patient notification and data collection

The South London Stroke Register (SLSR) is a prospective population-based stroke register set up in January 1995. The total source population of the SLSR area was 271,817 individuals, self-reported as 63% white, 28% black, and 9% other ethnic groups in the 2001 census[22].

A stroke was defined as rapidly developing clinical signs of focal (at times global) disturbance of cerebral function, lasting more than 24 hours or leading to death with no apparent cause other than that of vascular origin[23]. Patients with first-ever stroke in between 1st January 1995 and 31st December 2011, of all ages, residing in one of the 22 electoral wards of Lambeth and Southwark (an inner area of south London) and who gave written informed consent or assent to participate in the study were included. Exclusion criteria included patients with stroke recurrence, residing outside these south London wards and who refused to give written informed consent or assent. Multiple overlapping sources of notification were used to identify patients by specially trained doctors, nurses and field workers (hospital and community surveillance). After receiving notification of a stroke patient, he/she was contacted for registration within 48 hours where possible. The estimated completeness of case ascertainment in this population has been approximately 88% through a multinomial-logit capture recapture model[24]. Stroke severity at the time of maximum impairment was: 15.8%, 11.4% and 68.9% of patients had severe, moderate and mild unconsciousness [Glasgow coma scale

(GCS) scores stratified into three: severe (3-8), moderate (9-12) and mild (13-15)][19], respectively; and 41.7% and 35.5% of patients had urinary incontinence and dysphagia, respectively.

Structured questionnaires were used for initial registration and for follow-ups. The follow-ups were performed at 3 months and annually thereafter through face-to-face or through postal and telephonic interviews, depending on the capability and availability of the patient to complete the questionnaire. At follow-ups, Barthel Index (BI) and Frenchay Activities Index (FAI) were completed. BI measures basic ADL (self care tasks) through 10 questions, namely feeding, bathing, grooming, dressing, bowels, bladder, toilet, transfers (bed to chair and back), mobility (on level surfaces) and stairs. BI is a valid and reliable stroke research tool with scores ranging from 0 to 20[25,26]. Participants were categorised into one of the two groups: poor basic ADL (BI<15: severely/moderately inactive) and good basic ADL (BI>=15: mildly inactive/independent)[27]. FAI measures instrumental ADL, that is, social activities and more complex ADL (such as outdoor mobility, domestic chores, leisure and gainful work) through 15 questions. This is a valid and reliable tool with scores ranging from 0 to 45[28-31]. Participants were categorised into one of the two groups: poor instrumental ADL (FAI<=15: inactive) and good instrumental ADL (FAI>15: moderately active/independent)[31]. All cut-off points were pre-defined in order to determine poor outcomes.

The initial assessment included information on socio-demographics: age of stroke onset, sex, self-defined ethnicity, postcode [to determine Index of Multiple Deprivation (IMD) scores-categorised into tertiles (first tertile=least socio-economically deprived and third tertile=most socio-economically deprived)], pre-stroke living conditions, pre-stroke basic ADL; pre-stroke risk factors: smoking, alcohol drinking, hypertension, migraine, myocardial infarction, transient ischemic attack, diabetes mellitus, atrial fibrillation, peripheral vascular disease; pathological stroke subtype classification; stroke severity at the time of maximum impairment: consciousness level using GCS, dysphagia, urinary incontinence; and processes of acute stroke care: hospital admission, admission/transfer to a stroke unit, more than 50% of hospital admission spent in a stroke unit, brain imaging [computed tomography (CT) or magnetic resonance imaging (MRI)]. These indicators of the processes of acute stroke care are some of the useful proxy measures for the overall quality of stroke care[19].

Ethics

The study was ethically approved by the research ethics committees of Guy's and St. Thomas' National Health Service (NHS) Foundation Trust, King's College Hospital NHS Foundation Trust, National Hospital for Neurology and Neurosurgery (University College London Hospitals NHS Foundation Trust), St. George's Healthcare NHS Trust, and Chelsea and Westminster Hospital NHS Foundation Trust. Information sheets were distributed among all the eligible patients or their relatives, and written informed consents or assents were taken from those interested in participating in the research.

Statistical analyses

The chi-square test was used to investigate the association between ADL and categorical variables (socio-demographics, pre-stroke risk factors, stroke subtype, stroke severity and processes of acute stroke care). Seventeen years of SLSR data were divided into five year groups: 1995-1998, 1999-2001, 2002-2004, 2005-2007, and 2008-2011. Simple and multiple logistic regression analyses were performed to examine trends over time in the prevalence of poor ADL among stroke survivors in these five year groups, and to determine these trends in different socio-economic groups (IMD tertiles).

In multiple regression models, adjustments were performed for all the categorical variables. Sensitivity analyses were carried out using the 1st four year groups (1995-2007) and excluding the 5th year group (2008-2011) to examine these trends before relevant guidelines came into effect. Multiple regression models included a sample with missing values for these adjusted variables. Odds ratios (ORs), 95% confidence intervals (CIs) and P values were reported. All data were analyzed using STATA-12 for Windows software[32].

RESULTS

Data collected on 4,413 first-ever stroke patients between 1st January 1995 and 31st December 2011 were analysed. Figure 1 showed the number of stroke survivors with basic and instrumental ADL measured at 3 months and 1 year post-stroke. 1,107 (25.1%) patients died between stroke onset and 3 months follow-up, and 329 (7.5%) patients died between 3 months and 1 year follow-ups. At 3 months, 639 (30.5%) of the 2,094 survivors measured with BI had poor basic ADL, and 1,101 (56.5%) of the 1,948 survivors measured with FAI had poor instrumental ADL. At 1 year, 497 (25.2%) of the 1,971 survivors had poor basic ADL, and 888 (47.3%) of the 1,878 survivors had poor instrumental ADL.

Table 1 reported the characteristics of stroke survivors with poor and good basic and instrumental ADL measured at 3 months and 1 year post-stroke. Age of stroke onset, sex, ethnicity, IMD, pre-stroke living conditions, pre-stroke basic ADL, smoking, alcohol drinking, migraine, atrial fibrillation, stroke subtype, GCS, dysphagia, urinary incontinence, hospital admission and more than 50% of hospital admission spent in a stroke unit were associated with basic ADL at 3 months. All these factors, hypertension, transient ischemic attack, diabetes mellitus and admission/transfer to a stroke unit were associated with instrumental ADL at 3 months. At 1 year, all the 3 months basic ADL factors (except for IMD and more than 50% of hospital admission spent in a stroke unit), transient ischemic attack and diabetes mellitus were associated with basic ADL. Factors associated with instrumental ADL at 1 year were similar to the 3 months instrumental ADL factors (except for sex, IMD, hypertension and admission/transfer to a stroke unit).

Figure 2 showed the crude poor basic and instrumental ADL measured at 3 months and 1 year post-stroke over seventeen years (1995-2011). At 3 months, the prevalence of poor basic ADL among stroke survivors reduced significantly from 33.4% in 1995-1998 to 25.1% in 2008-2011 (trend p<0.001), and poor instrumental ADL declined significantly from 59.8% to 53.1% (trend p=0.002). The corresponding figures at 1 year were: from 27.8% to 24.3% (trend p=0.064) and from 51.6% to 42.8% (trend p=0.006). At 1 year, the prevalence of poor basic ADL among stroke survivors reduced significantly from 1995 to 2007 (trend p=0.033).

Figure 3 showed the crude poor basic and instrumental ADL measured at 3 months and 1 year post-stroke in three socio-economic groups over seventeen years (1995-2011). In simple regression analyses, significant reduction in poor ADL at 3 months and 1 year was observed over time only in the first IMD tertile.

Table 2 reported the adjusted poor basic and instrumental ADL measured at 3 months and 1 year post-stroke over seventeen years and in three socio-economic groups (1995-2011). The risk of poor basic ADL at 3 months and 1 year reduced significantly from 1995 to 2011. At 3 months, adjusted ORs (95% CIs) were 1.15 (0.69-1.94) in 1999-2001, 0.59 (0.39-0.88) in 2002-2004, 0.72 (0.46-1.12) in 2005-2007 and 0.62 (0.39-0.98) in 2008-2011 as compared to 1995-1998 (trend p<0.001). Similarly at 1 year, the corresponding figures were 0.93 (0.58-1.51), 0.47 (0.31-0.71), 0.59 (0.38-0.91) and 0.64 (0.40-

Table 1- Characteristics of stroke survivors with poor and good basic and instrumental ADL measured at 3 months and 1 year post-stroke: SLSR 1995-2011												
	3 months						1 year					
	BI (n=2094)			FAI (n=1948)			BI (n=1971)			FAI (n=1878)		
	BI<15 (n=639)	BI>=15 (n=1455)	P value	FAI<=15 (n=1101)	FAI>15 (n=847)	P value	BI<15 (n=497)	BI>=15 (n=1474)	P value	FAI<=15 (n=888)	FAI>15 (n=990)	P value
Socio-demographics												
Age of stroke onset (years)			<0.001			<0.001			<0.001			<0.001
0-64	132 (20.7)	564 (38.8)		284 (25.8)	368 (43.4)		113 (22.7)	602 (40.8)		227 (25.6)	458 (46.3)	
65-74	173 (27.1)	421 (28.9)		300 (27.2)	247 (29.2)		137 (27.6)	432 (29.3)		264 (29.7)	286 (28.9)	
75-84	201 (31.5)	358 (24.6)		327 (29.7)	192 (22.7)		158 (31.8)	358 (24.3)		277 (31.2)	206 (20.8)	
85+	133 (20.8)	112 (7.7)		190 (17.3)	40 (4.7)		89 (17.9)	82 (5.6)		120 (13.5)	40 (4.0)	
Sex			<0.001			0.006			<0.001			0.915
Male	280 (43.8)	823 (56.6)		549 (49.9)	476 (56.2)		224 (45.1)	828 (56.2)		475 (53.5)	532 (53.7)	
Female	359 (56.2)	632 (43.4)		552 (50.1)	371 (43.8)		273 (54.9)	646 (43.8)		413 (46.5)	458 (46.3)	
Ethnicity			0.048			<0.001			0.005			<0.001
White	442 (69.2)	1023 (70.3)		736 (66.8)	629 (74.3)		349 (70.2)	1006 (68.2)		596 (67.1)	701 (70.8)	
Black	142 (22.2)	340 (23.4)		276 (25.1)	167 (19.7)		100 (20.1)	367 (24.9)		202 (22.7)	235 (23.7)	
Other	53 (8.3)	79 (5.4)		85 (7.7)	41 (4.8)		46 (9.3)	85 (5.8)		84 (9.5)	42 (4.2)	
Unknown	2 (0.3)	13 (0.9)		4 (0.4)	10 (1.2)		2 (0.4)	16 (1.1)		6 (0.7)	12 (1.2)	
IMD			0.044			0.021			0.3			0.06
1sttertile	190 (29.7)	514 (35.3)		345 (31.3)	313 (37.0)		155 (31.2)	512 (34.7)		276 (31.1)	359 (36.3)	
2ndtertile	223 (34.9)	477 (32.8)		364 (33.1)	275 (32.5)		177 (35.6)	481 (32.6)		306 (34.5)	316 (31.9)	
3rdtertile	224 (35.1)	461 (31.7)		389 (35.3)	259 (30.6)		165 (33.2)	481 (32.6)		306 (34.5)	315 (31.8)	
Unknown	2 (0.3)	3 (0.2)		3 (0.3)	0		0	0		0	0	
Pre-stroke living conditions			<0.001			<0.001			<0.001			<0.001
Home alone	181 (28.3)	471 (32.4)		307 (27.9)	297 (35.1)		142 (28.6)	464 (31.5)		246 (27.7)	325 (32.8)	
Home with someone	300 (46.9)	751 (51.6)		563 (51.1)	425 (50.2)		236 (47.5)	773 (52.4)		456 (51.4)	507 (51.2)	
Institution	73 (11.4)	70 (4.8)		107 (9.7)	27 (3.2)		56 (11.3)	62 (4.2)		77 (8.7)	34 (3.4)	
Unknown	85 (13.3)	163 (11.2)		124 (11.3)	98 (11.6)		63 (12.7)	175 (11.9)		109 (12.3)	124 (12.5)	
Pre-stroke basic ADL			<0.001			<0.001			<0.001			<0.001

Good (BI>=15)	557 (87.2)	1444 (99.2)		1021 (92.7)	842 (99.4)		440 (88.5)	1463 (99.3)		827 (93.1)	987 (99.7)	
Poor (BI<15)	82 (12.8)	11 (0.8)		80 (7.3)	5 (0.6)		57 (11.5)	11 (0.7)		61 (6.9)	3 (0.3)	
Pre-stroke risk factors												
Smoking			0.001			0.002			0.002			0.047
Non-smoker	442 (69.2)	918 (63.1)		748 (67.9)	524 (61.9)		336 (67.6)	904 (61.3)		577 (65.0)	605 (61.1)	
Current smoker	175 (27.4)	516 (35.5)		327 (29.7)	311 (36.7)		144 (29.0)	546 (37.0)		290 (32.7)	369 (37.3)	
Unknown	22 (3.4)	21 (1.4)		26 (2.4)	12 (1.4)		17 (3.4)	24 (1.6)		21 (2.4)	16 (1.6)	
Alcohol drinking			<0.001			<0.001			0.001			<0.001
No	283 (44.3)	488 (33.5)		444 (40.3)	271 (32.0)		198 (39.8)	485 (32.9)		349 (39.3)	303 (30.6)	
Yes	304 (47.6)	894 (61.4)		587 (53.3)	536 (63.3)		257 (51.7)	898 (60.9)		485 (54.6)	617 (62.3)	
Unknown	52 (8.1)	73 (5.0)		70 (6.4)	40 (4.7)		42 (8.5)	91 (6.2)		54 (6.1)	70 (7.1)	
Hypertension			0.614			0.001			0.371			0.147
No	205 (32.1)	486 (33.4)		322 (29.2)	307 (36.2)		155 (31.2)	488 (33.1)		277 (31.2)	337 (34.0)	
Yes	413 (64.6)	930 (63.9)		750 (68.1)	515 (60.8)		328 (66.0)	934 (63.4)		585 (65.9)	616 (62.2)	
Unknown	21 (3.3)	39 (2.7)		29 (2.6)	25 (3.0)		14 (2.8)	52 (3.5)		26 (2.9)	37 (3.7)	
Migraine			0.014			0.011			0.004			0.001
No	567 (88.7)	1272 (87.4)		981 (89.1)	732 (86.4)		452 (90.9)	1283 (87.0)		803 (90.4)	854 (86.3)	
Yes	29 (4.5)	110 (7.6)		60 (5.4)	71 (8.4)		18 (3.6)	107 (7.3)		39 (4.4)	80 (8.1)	
Unknown	43 (6.7)	73 (5.0)		60 (5.4)	44 (5.2)		27 (5.4)	84 (5.7)		46 (5.2)	56 (5.7)	
Myocardial infarction			0.185			0.102			0.473			0.063
No	541 (84.7)	1271 (87.4)		944 (85.7)	747 (88.2)		429 (86.3)	1288 (87.4)		766 (86.3)	869 (87.8)	
Yes	73 (11.4)	140 (9.6)		122 (11.1)	75 (8.9)		52 (10.5)	138 (9.4)		99 (11.1)	84 (8.5)	
Unknown	25 (3.9)	44 (3.0)		35 (3.2)	25 (3.0)		16 (3.2)	48 (3.3)		23 (2.6)	37 (3.7)	
Transient ischemic attack			0.103			0.005			0.004			<0.001
No	521 (81.5)	1233 (84.7)		900 (81.7)	728 (86.0)		397 (79.9)	1253 (85.0)		717 (80.7)	859 (86.8)	
Yes	97 (15.2)	184 (12.6)		172 (15.6)	95 (11.2)		83 (16.7)	172 (11.7)		145 (16.3)	94 (9.5)	
Unknown	21 (3.3)	38 (2.6)		29 (2.6)	24 (2.8)		17 (3.4)	49 (3.3)		26 (2.9)	37 (3.7)	
Diabetes mellitus			0.189			<0.001			0.006			<0.001
No	490 (76.7)	1156 (79.5)		835 (75.8)	697 (82.3)		373 (75.1)	1175 (79.7)		668 (75.2)	802 (81.0)	
Yes	130 (20.3)	262 (18.0)		239 (21.7)	126 (14.9)		113 (22.7)	250 (17.0)		198 (22.3)	152 (15.4)	

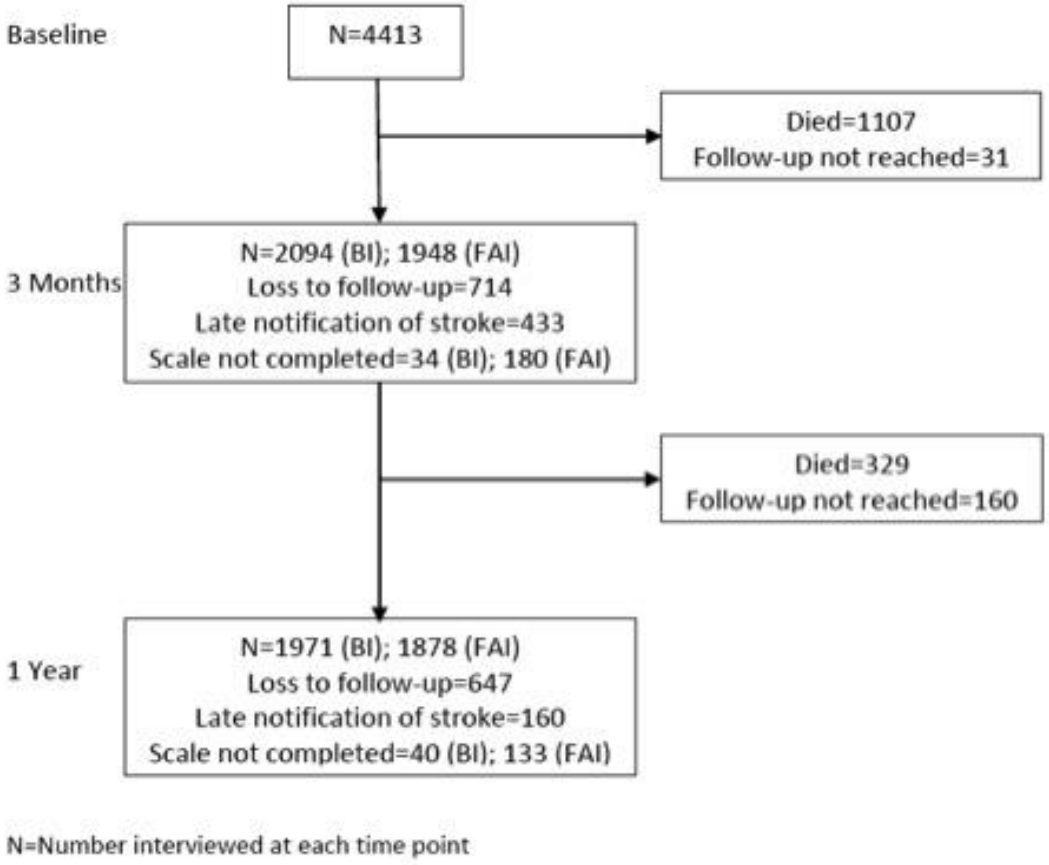
Unknown	19 (3.0)	37 (2.5)		27 (2.5)	24 (2.8)		11 (2.2)	49 (3.3)		22 (2.5)	36 (3.6)	
Atrial fibrillation			0.004			0.001			<0.001			0.002
No	511 (80.0)	1248 (85.8)		900 (81.7)	737 (87.0)		395 (79.5)	1281 (86.9)		739 (83.2)	862 (87.1)	
Yes	101 (15.8)	167 (11.5)		167 (15.2)	86 (10.2)		83 (16.7)	146 (9.9)		122 (13.7)	91 (9.2)	
Unknown	27 (4.2)	40 (2.7)		34 (3.1)	24 (2.8)		19 (3.8)	47 (3.2)		27 (3.0)	37 (3.7)	
Peripheral vascular disease			0.944			0.413			0.835			0.517
No	574 (89.8)	1337 (91.9)		1007 (91.5)	772 (91.1)		457 (92.0)	1345 (91.2)		819 (92.2)	897 (90.6)	
Yes	21 (3.3)	48 (3.3)		34 (3.1)	32 (3.8)		15 (3.0)	47 (3.2)		27 (3.0)	35 (3.5)	
Unknown	44 (6.9)	70 (4.8)		60 (5.4)	43 (5.1)		25 (5.0)	82 (5.6)		42 (4.7)	58 (5.9)	
Stroke subtype			0.006			<0.001			0.005			<0.001
Ischemic	536 (83.9)	1176 (80.8)		911 (82.7)	687 (81.1)		413 (83.1)	1200 (81.4)		743 (83.7)	799 (80.7)	
Primary intra-cerebral haemorrhage	70 (11.0)	140 (9.6)		125 (11.4)	69 (8.1)		57 (11.5)	138 (9.4)		103 (11.6)	86 (8.7)	
Subarachnoid haemorrhage	10 (1.6)	55 (3.8)		23 (2.1)	37 (4.4)		6 (1.2)	66 (4.5)		14 (1.6)	51 (5.2)	
Undefined	23 (3.6)	84 (5.8)		42 (3.8)	54 (6.4)		21 (4.2)	70 (4.7)		28 (3.2)	54 (5.5)	
Stroke severity												
GCS			<0.001			<0.001			<0.001			<0.001
Severe (≤8)	42 (6.6)	35 (2.4)		57 (5.2)	13 (1.5)		29 (5.8)	47 (3.2)		47 (5.3)	26 (2.6)	
Moderate (9–12)	109 (17.1)	88 (6.0)		137 (12.4)	39 (4.6)		75 (15.1)	92 (6.2)		109 (12.3)	55 (5.6)	
Mild (≥13)	463 (72.5)	1305 (89.7)		874 (79.4)	780 (92.1)		381 (76.7)	1304 (88.5)		709 (79.8)	889 (89.8)	
Unknown	25 (3.9)	27 (1.9)		33 (3.0)	15 (1.8)		12 (2.4)	31 (2.1)		23 (2.6)	20 (2.0)	
Dysphagia			<0.001			<0.001			<0.001			<0.001
No	301 (47.1)	1140 (78.4)		652 (59.2)	690 (81.5)		265 (53.3)	1092 (74.1)		526 (59.2)	761 (76.9)	
Yes	307 (48.0)	224 (15.4)		401 (36.4)	93 (11.0)		198 (39.8)	259 (17.6)		309 (34.8)	132 (13.3)	
Unknown	31 (4.9)	91 (6.3)		48 (4.4)	64 (7.6)		34 (6.8)	123 (8.3)		53 (6.0)	97 (9.8)	
Urinary incontinence			<0.001			<0.001			<0.001			<0.001
No	223 (34.9)	1147 (78.8)		557 (50.6)	724 (85.5)		216 (43.5)	1129 (76.6)		465 (52.4)	811 (81.9)	
Yes	389 (60.9)	278 (19.1)		509 (46.2)	105 (12.4)		264 (53.1)	302 (20.5)		392 (44.1)	151 (15.3)	
Unknown	27 (4.2)	30 (2.1)		35 (3.2)	18 (2.1)		17 (3.4)	43 (2.9)		31 (3.5)	28 (2.8)	
Processes of acute stroke care												

Hospital admission			<0.001			<0.001			<0.001			<0.001
No	38 (5.9)	203 (14.0)		75 (6.8)	144 (17.0)		43 (8.7)	236 (16.0)		87 (9.8)	181 (18.3)	
Yes	601 (94.1)	1252 (86.0)		1026 (93.2)	703 (83.0)		454 (91.3)	1238 (84.0)		801 (90.2)	809 (81.7)	
Admission/transfer to a stroke unit			0.052			0.012			0.446			0.744
No	243 (38.0)	449 (30.9)		407 (37.0)	237 (28.0)		168 (33.8)	484 (32.8)		310 (34.9)	306 (30.9)	
Yes	349 (54.6)	787 (54.1)		605 (55.0)	456 (53.8)		279 (56.1)	737 (50.0)		480 (54.1)	490 (49.5)	
Unknown	47 (7.4)	219 (15.1)		89 (8.1)	154 (18.2)		50 (10.1)	253 (17.2)		98 (11.0)	194 (19.6)	
>50% of hospital admission spent in a stroke unit			<0.001			<0.001			0.301			0.009
No	306 (47.9)	516 (35.5)		489 (44.4)	272 (32.1)		203 (40.8)	550 (37.3)		374 (42.1)	374 (42.1)	
Yes	219 (34.3)	625 (43.0)		433 (39.3)	366 (43.2)		192 (38.6)	587 (39.8)		336 (37.8)	336 (37.8)	
Unknown	114 (17.8)	314 (21.6)		179 (16.3)	209 (24.7)		102 (20.5)	337 (22.9)		178 (20.0)	178 (20.0)	
Brain imaging (CT/MRI)			0.977			0.952			0.46			0.647
No	14 (2.2)	31 (2.1)		22 (2.0)	17 (2.0)		11 (2.2)	25 (1.7)		18 (2.0)	17 (1.7)	
Yes	613 (95.9)	1370 (94.2)		1053 (95.6)	798 (94.2)		474 (95.4)	1410 (95.7)		853 (96.1)	942 (95.2)	
Unknown	12 (1.9)	54 (3.7)		26 (2.4)	32 (3.8)		12 (2.4)	39 (2.6)		17 (1.9)	31 (3.1)	

n (%), chi-square test, P value excludes unknown

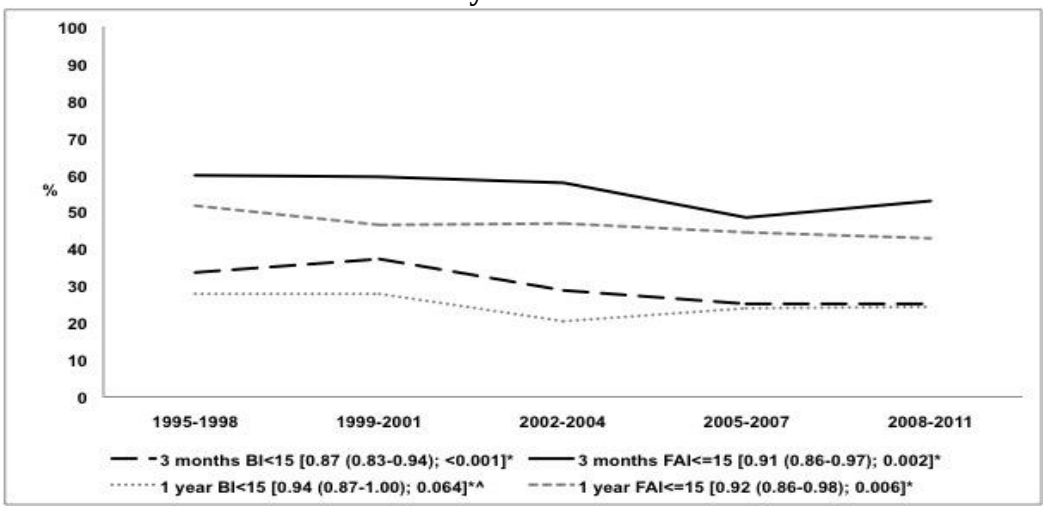
Table 2- Adjusted poor basic and instrumental ADL measured at 3 months and 1 year post-stroke over seventeen years and in three socio-economic groups: SLSR 1995-2011										
		1995-1998	**1999-2001**	**2002-2004**	**2005-2007**	**2008-2011**	**Trend P**	**IMD group**	**Adjusted OR (95% CI)**	**Trend P**
3 months										
BI<15	**OR (95% CI), P**	1	1.15 (0.69-1.94), 0.588	0.59 (0.39-0.88), 0.009	0.72 (0.46-1.12), 0.147	0.62 (0.39-0.98), 0.039	<0.001	**1st tertile**	0.79 (0.66-0.93)	0.006
								2nd tertile	0.76 (0.64-0.90)	0.001
								3rd tertile	0.93 (0.80-1.09)	0.37
FAI<=15	**OR (95% CI), P**	1	1.15 (0.69-1.93), 0.586	0.93 (0.64-1.34), 0.684	0.64 (0.42-0.96), 0.033	0.78 (0.51-1.20), 0.261	0.005	**1st tertile**	0.83 (0.71-0.97)	0.019
								2nd tertile	0.86 (0.74-1.00)	0.047
								3rd tertile	0.98 (0.85-1.14)	0.815
1 year										
BI<15	**OR (95% CI), P**	1	0.93 (0.58-1.51), 0.775	0.47 (0.31-0.71), <0.001	0.59 (0.38-0.91), 0.018	0.64 (0.40-1.01), 0.055	0.001	**1st tertile**	0.76 (0.63-0.90)	0.002
								2nd tertile	0.93 (0.79-1.09)	0.377
								3rd tertile	0.83 (0.70-0.99)	0.043
FAI<=15	**OR (95% CI), P**	1	0.73 (0.47-1.15), 0.174	0.76 (0.53-1.09), 0.142	0.78 (0.53-1.16), 0.219	0.79 (0.52-1.20), 0.274	0.004	**1st tertile**	0.86 (0.73-1.00)	0.05
								2nd tertile	0.91 (0.79-1.05)	0.208
								3rd tertile	0.90 (0.78-1.04)	0.161

Figure 1- Number of stroke survivors with basic and instrumental ADL measured at 3 months and 1 year post-stroke



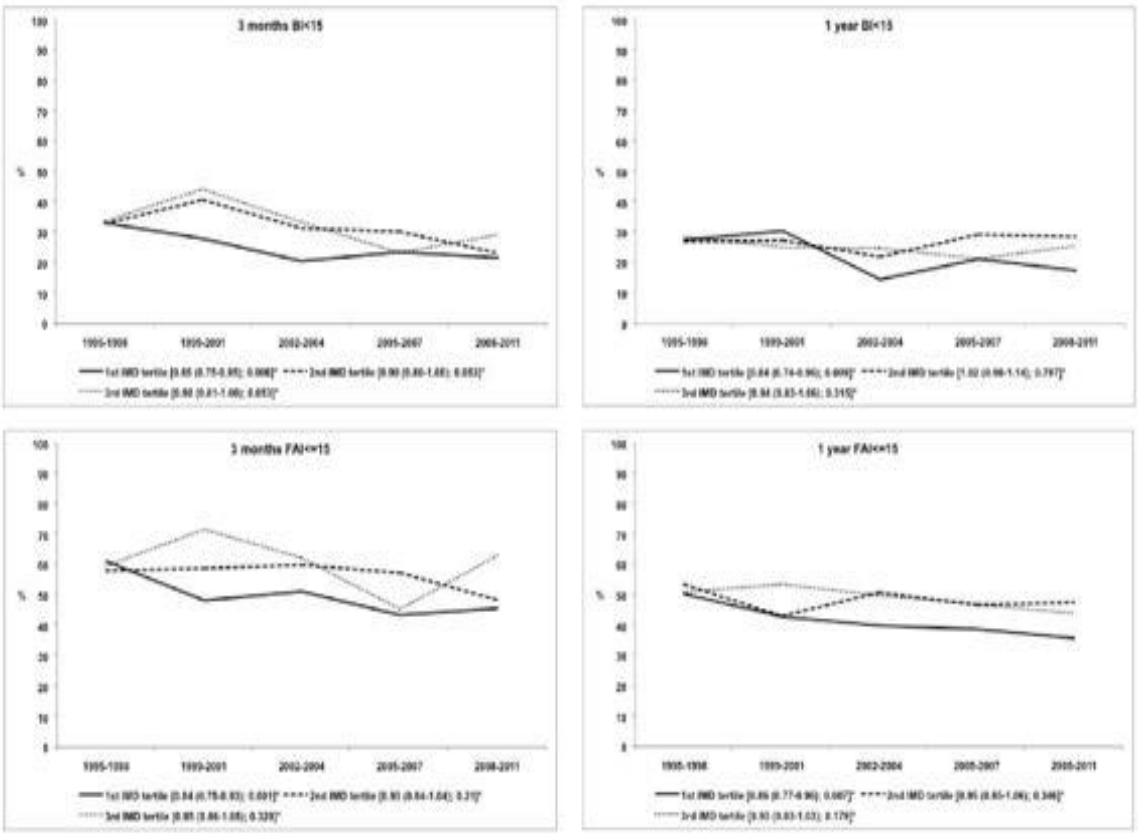
N=Number interviewed at each time point

Figure 2- Crude poor basic and instrumental ADL measured at 3 months and 1 year post-stroke over seventeen years: SLSR 1995-2011



*[Unadjusted OR (95% CI); Trend P]. ^Significant trend for 1995-2007.

Figure 3- Crude poor basic and instrumental ADL measured at 3 months and 1 year post-stroke in three socio-economic groups over seventeen years: SLSR 1995-2011



*[Unadjusted OR (95% CI); Trend P].

1.01) with trend p=0.001. At 3 months and 1 year, the risk of poor instrumental ADL declined significantly from 1995 to 2011. At 3 months, adjusted ORs (95% CIs) were 1.15 (0.69-1.93) in 1999-2001, 0.93 (0.64-1.34) in 2002-2004, 0.64 (0.42-0.96) in 2005-2007 and 0.78 (0.51-1.20) in 2008-2011 as compared to 1995-1998 (trend p=0.005). Similarly at 1 year, the corresponding figures were 0.73 (0.47-1.15), 0.76 (0.53-1.09), 0.78 (0.53-1.16) and 0.79 (0.52-1.20) with trend p=0.004. In multiple regression analyses, significant reduction in poor ADL at 3 months was observed over time among stroke survivors in the first and second IMD tertiles (adjusted trend p=0.006 and 0.001, respectively in poor basic ADL; 0.019 and 0.047, respectively in poor instrumental ADL). At 1 year, poor basic ADL declined significantly among stroke survivors in the first and third IMD tertiles (adjusted trend p=0.002 and 0.043, respectively), and poor instrumental ADL reduced significantly only in the first IMD tertile (adjusted trend p=0.05).

DISCUSSION

ADL has improved over time among stroke survivors in this population-based cohort study. However, disparities in ADL improvement still exist in different socio-economic groups. To the best of knowledge, this is the first study to report ADL trends over time among stroke survivors. A number of ADL time trend studies have been conducted especially among older people (general studies but not specific to stroke) using different methodologies (such as different case-definitions, measuring tools and cut-off points)[33-39].

The risk of poor ADL at 3 months and 1 year post-stroke decreased significantly from 1995 to 2011. The prevalence of poor ADL among older people declined over time in the UK and in the United States of America (USA)[33-38]. However, another research conducted among older people in England documented an increase in the crude poor ADL over time[33], but also reported a decline in the moderate ADL limitation over the same time period[39]. The post-stroke ADL could be improved through effective stroke management[15,40]. The receipt of acute stroke care has improved over time in this population[41], and this could explain the post-stroke ADL improvement over time. However, ADL is also improving in the general population over time, and further research is needed to explore all the possible reasons behind this ADL improvement.

Poor ADL at 3 months reduced significantly over time among stroke survivors in the least and second least deprived groups, but not in the most deprived group. At 1 year, poor basic and instrumental ADL declined significantly in the least and most deprived groups, and only in the least deprived group, respectively. In England, the age-standardised poor ADL prevalence declined over time in social classes I, II and V whereas it increased in social class IV[39]. In the USA, the ADL improved over time among older people in the highest income quintile group, but not in the lowest one[36]. Non-manual stroke patients in this population were more likely to be admitted to hospitals and stroke units[42] and receive brain imaging[41] as compared to manual stroke patients, and this could explain the post-stroke ADL improvement over time in the least deprived group. Poor basic ADL at 1 year also decreased significantly over time in the most deprived group, which could be due to other confounding factors (such as stroke recurrence) that were not adjusted for in this study, and needs further research.

This study has a number of strengths and weaknesses. The SLSR is a multiethnic population-based stroke register with a large number of registered patients (hospitalised and non-hospitalised patients), long-term follow-ups and includes a vast number of baseline variables which have never been explored before. Multiple overlapping sources of notification were used to identify patients. A standardised protocol was used for data collection by specially trained doctors, nurses and field

workers. Perhaps, no dataset worldwide would be representative to allow such ADL time trend analyses. The study findings could be generalized to other similar populations with similar healthcare provisions.

ADL measurement was subjective to participants and thus, valid and reliable tools were used to measure ADL. However, objectively measured ADL trends over time could be different, and further studies needs to be carried out. The focus of this study was at 3 months and 1 year after stroke (1995-2011), and further research that focuses on more than a year is needed. However, the outcomes remain comparatively stable after 1 year of stroke[6]. This study provided a better picture of the after-effects of acute stroke care on ADL improvement at 3 months and 1 year post-stroke, and included both severe and milder stroke survivors.

All the structured questionnaires had been amended regularly to reflect changes in evidence, and some of the processes of acute stroke care variables were added in 2005. These variables could not be used, as the available data were limited for analyses. However, four indicators of the processes of acute stroke care were included, which are some of the useful proxy measures for the overall quality of stroke care[19]. Moreover, if a patient has been admitted/transferred to a stroke unit in London, it can be assumed that the patient will receive adequate care from the stroke-skilled multidisciplinary team (which includes specialist stroke physician, physiotherapist, occupational therapist, speech and language therapist, dietician, psychologist and social worker) and appropriate secondary prevention drugs.

Missing data could lead to bias, but it was generally low in this study. Multiple regression analyses included a sample with missing values for the adjusted variables. The loss to follow-up could lead to bias, and this could be an issue in some socio-demographic groups. People who are healthier or wealthier may be more likely to participate in research follow-ups[43]. However, any such group in the analyses were not found. Unlike some other cohort and stroke register studies, loss to follow-up was reported. Some patients were registered retrospectively and thus, 3 months and 1 year follow-ups could not be performed. This rate was higher at 3 months as compared to 1 year. The south London population is quite mobile, with a large number of migrants. This increases the chances of loss to follow-up, however every attempt was made to keep a record of the latest contact details of the patient (through general practitioners, hospitals or relatives). In case the patient migrated to an area outside London, postal follow-up was completed.

CONCLUSION

ADL has improved over time among stroke survivors. This may reflect the effectiveness of acute stroke care. However, disparities in ADL improvement still exist in different socio-economic groups, and health inequality needs to be tackled.

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CONFLICT OF INTEREST

None

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